# 299-E28-24 (A6800)

## Log Data Report

### Borehole Information:

| Borehole: | 299-E-28-24 (A6800) | | Site: | 216-B-5 Injection/Reverse Well | |
|---|---|---|---|---|---|
| Coordinates (WA State Plane) | | GWL[1] (ft): | 288.1 | GWL Date: | 10/01 |
| North | East | Drill Date | TOC[2] Elevation | Total Depth (ft) | Type |
| 136728 | 573785 | 02/80 | N/A[3] | 329.0 | Cable tool |

### Casing Information:

| Casing Type | Stickup (ft) | Outer Diameter (in.) | Inside Diameter (in.) | Thickness (in.) | Top (ft) | Bottom (ft) |
|---|---|---|---|---|---|---|
| Steel (welded) | 1.75 | 8.625 | 8.0 | 0.3125 | 0 | 318 |
| Steel (threaded) | 1.65 | 4.25 | 3.75 | 0.25 | 0 | 278 |
| #10 slotted SS screen | none | 4.25 | 3.75 | 0.25 | 277 | 327 |

### Borehole Notes:

The casing depth information provided above is derived from a well construction and completion summary obtained from *Hanford Wells* (Chamness and Merz 1993) and from *Summaries of Well Construction Data and Field Observations for Existing 200-East Aggregate Operable Unit Resource Protection Wells* (Ledgerwood 1992). The casing size information for the 4-in. and 8-in. steel casings is confirmed from tape and caliper measurements collected in the field by MACTEC-ERS personnel. For analysis purposes, the thickness of the 4-in. stainless steel screen is assumed to be the same as the 4-in. steel casing.

This borehole was originally drilled in 1979 approximately 20 ft southeast of the 216-B-5 Injection/Reverse Well. During drilling a 10-in. casing had been placed to 20 ft in depth. The 8-in. casing was originally placed to the bottom of the borehole. A 4-in. casing was introduced inside the 8-in. casing to a depth of 278 ft and a 4-in. screen was placed from 277 to 327 ft. The 8-in. casing was pulled to about 318 ft to expose the screened interval to the formation water; the casing was reportedly broken at about 80 ft during retraction, suggesting casing is missing from an interval around 80 ft. On the basis of total gamma measurements this interval is believed to be from about 83 to 98 ft in depth. The 10-in. casing is reported to have been removed and a grout seal emplaced around the 8-in. casing to an unspecified depth. A 2-ft cement pad was poured at the surface to complete the seal.

Logging measurements are referenced to the top of the 8-in. casing. The depth to groundwater in the area has been reported at about 294 ft in 1948 (Smith 1980) and at about 280 and 282.9 ft in 1980 and 1991, respectively (Ledgerwood 1992). The reported current depth to groundwater (288.1 ft) is derived from personal communication with a Bechtel Hanford Incorporated site representative.

### Logging Equipment Information:

| Logging System: | Gamma 1D | | Type: | SGLS (35%) |
|---|---|---|---|---|
| Calibration Date: | 07/01 | Calibration Reference: | GJO-2001-243-TAR | |
| | | Logging Procedure: | MAC-HGLP 1.6.5 | |

## Spectral Gamma Logging System (SGLS) Log Run Information:

| Log Run | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Date | 10/30/01 | 10/31/01 | 11/01/01 | 11/02/01 | 11/06/01 |
| Logging Engineer | Musial | Musial | Musial | Musial | Musial |
| Start Depth | 2.0 | 69.0 | 150.0 | 182.0 | 208.0 |
| Finish Depth | 70.0 | 151.0 | 183.0 | 238.0 | 248.0 |
| Count Time (sec) | 100 | 100 | 100 | 100 | 100 |
| Live/Real | R | R | R | R | R |
| Shield (Y/N) | N | N | N | N | N |
| MSA Interval (ft) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ft/min | n/a[4] | n/a | n/a | n/a | n/a |
| Pre-Verification | A0028CAB | A0029CAB | A0030CAB | A0031CAB | A0032CAB |
| Start File | A0028000 | A0029000 | A0030000 | A0031000 | A0032000 |
| Finish File | A0028136 | A0029164 | A0030066 | A0031112 | A0032080 |
| Post-Verification | A0028CAA | A0029CAA | A0030CAA | A0031CAA | A0032CAA |

| Log Run | 6 | | | | |
|---|---|---|---|---|---|
| Date | 11/07/01 | | | | |
| Logging Engineer | Musial | | | | |
| Start Depth | 287.0 | | | | |
| Finish Depth | 247.0 | | | | |
| Count Time (sec) | 100 | | | | |
| Live/Real | R | | | | |
| Shield (Y/N) | N | | | | |
| MSA Interval (ft) | 0.5 | | | | |
| ft/min | n/a | | | | |
| Pre-Verification | A0033CAB | | | | |
| Start File | A0033000 | | | | |
| Finish File | A0033080 | | | | |
| Post-Verification | A0033CAA | | | | |

## Logging Operation Notes:

Spectral gamma logging was performed in this borehole during October 2001 on six separate days. Logging was terminated at a depth of 287 ft before groundwater was encountered. Waste management issues restrict logging below the groundwater level. A repeat section was collected between 208 and 238 ft to measure logging system performance.

## Analysis Notes:

| Analyst: | Henwood | Date: | 11/19/01 | Reference: | MAC-VZCP 1.7.9 Rev. 2 |
|---|---|---|---|---|---|

Pre-run and post-run verification of the logging system were performed for each day's log event. The efficiency (peak counts per second) of the logging system was consistently lower each day in the post-run verification as compared to the pre-run verification. This change was generally in the range of 6 to 13 percent. The cause of this discrepancy is being investigated. Evaluation of the spectra indicates the detector is functioning normally and the log data are provisionally accepted, subject to further review and analysis. The post-run verifications were used for the energy and resolution calibration necessary to process the data.

Casing corrections for 0.322-in. and 0.237-in.-thick casings were applied for the 8-in. and 4-in. steel casings, respectively. These values are within the error of the field measurements collected to confirm casing size and represent the published thicknesses for ASTM schedule-40 steel pipe, a common borehole casing at Hanford. The 4-in. stainless steel slotted casing was also assumed to be schedule-40 casing for analysis purposes. Where more than one casing exists at a depth the casing correction is additive (e.g., an

8-in. and 4-in. casing would be the correction for 0.322 + 0.237 = 0.559). Log data between 83 and 98 ft were corrected for a single 4-in. casing thickness. On the basis of total gamma measurements and a report that the 8-in. casing was separated during retraction from the borehole, the 8-in. casing is believed to be missing from this depth interval.

Each spectrum collected during a log run was processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL using an efficiency function and corrections for casing and dead time as appropriate. Where dead time is greater than about 40 percent, pulse pileup and peak spreading effects tend to result in underestimation of peak count rates. The $^{214}$Bi peak at 1764 keV was used to determine the naturally occurring $^{238}$U concentrations rather than the $^{214}$Bi peak at 609 keV. The higher energy 1764-keV energy peak exhibits slightly better count rates than the 609-keV peak because of less gamma attenuation caused by the dual casings in this borehole.

## Log Plot Notes:

Separate log plots are provided for the man-made radionuclide ($^{137}$Cs) detected in the borehole, naturally occurring radionuclides ($^{40}$K, $^{238}$U, $^{232}$Th [KUT]), a combination of man-made, KUT, and soil sample results of radionuclides (analyzed in 1980), total gamma plotted with dead time, and a repeat section plot. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. These errors are discussed in the calibration report. Soil sample results are derived from the 216-B-5 Reverse Well Characterization Study (Smith 1980).

## Results and Interpretations:

$^{137}$Cs is detected nearly continuously throughout the borehole at low levels (i.e., less than about 1 pCi/g). Two anomalous zones occur, one at about 80 ft in depth, and another beginning at about 270 ft. The low level concentrations pervasive in the borehole are probably the result of contamination inside either the 4- or 8-in. casing. The zone at 80 ft with a maximum concentration of about 30 pCi/g may also be the result of casing contamination. The $^{137}$Cs contamination zone beginning at 270 ft probably extends to at least 330 ft as suggested by the soil sample results shown in the combination plot. The profile of the $^{137}$Cs contamination between 270 and 287 ft closely fits the 1980 $^{137}$Cs soil sample results (Smith 1980) for the same depth interval. Comparison of the decayed concentrations of $^{137}$Cs in the soil samples to the current $^{137}$Cs concentrations determined by logging indicates an over-correction for casing resulting in calculated concentrations being slightly high in the log data. A maximum $^{137}$Cs concentration of about 3,000 pCi/g at a depth of about 272 ft is measured with both methods.

Soil sample results from 1980 (Smith 1980) show $^{137}$Cs, strontium-90 ($^{90}$Sr), Americium-241 ($^{241}$Am), and plutonium-239/240 ($^{239/240}$Pu) contamination between about 240 and 330 ft; possible detection of $^{241}$Am and $^{239/240}$Pu also occurred in single soil samples at 50 and 170 ft in depth. These radionuclides are not generally detectable by the SGLS using normal counting times. Gamma rays emitted by $^{241}$Am and $^{239}$Pu that would have the best chance of being detected with the SGLS are at the 59.5- and 129.3-keV energy levels, respectively. Although the gamma ray yield of $^{241}$Am is fairly high (i.e., 36 %), the energy is so low that gamma attenuation by the casing is a major factor in detection. The gamma energy of $^{239}$Pu at 129.3 keV is also relatively low and the yield is very low (0.0063 %). $^{90}$Sr does not emit a gamma ray and can only be inferred from an elevated low-energy gamma ray continuum given concentrations exceeding about 1,000 pCi/g. The ability to infer the existence of $^{90}$Sr, even at high concentrations, would be further degraded by the incoherent downscattering of gamma rays in the low energy continuum. Therefore, it is unlikely any of these radionuclides with the exception of $^{137}$Cs can be detected in a dual casing configuration and/or within groundwater using short counting times.

It is recommended that the interval below the water table be logged with the SGLS to confirm the existence of $^{137}Cs$ and attempt to measure the other radionuclides. One or two depth intervals within this zone should be selected for long counting times to determine if $^{241}Am$, $^{239}Pu$, or $^{90}Sr$ can be detected or inferred. In order to relog this borehole interval below the groundwater, waste management issues must be resolved.

The KUT log profiles are essentially featureless. The counting time (100 seconds) does not appear to have been sufficient to obtain statistically meaningful full energy peaks as evidenced by the large error bars in the KUT plots. The dual casings and grout result in significant gamma attenuation. The cause of an apparent change in the KUT and total gamma at 55 ft is unknown and probably cannot entirely, if at all, be attributed to lithology changes. It appears grout may have been placed as a surface seal to 55 ft rather than 20 ft as reported by Ledgerwood (1992).

A repeat log section was collected between 208 and 238 ft. The log data show good repeatability for depth and radionuclide concentration.

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[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not available
[4] n/a – not applicable

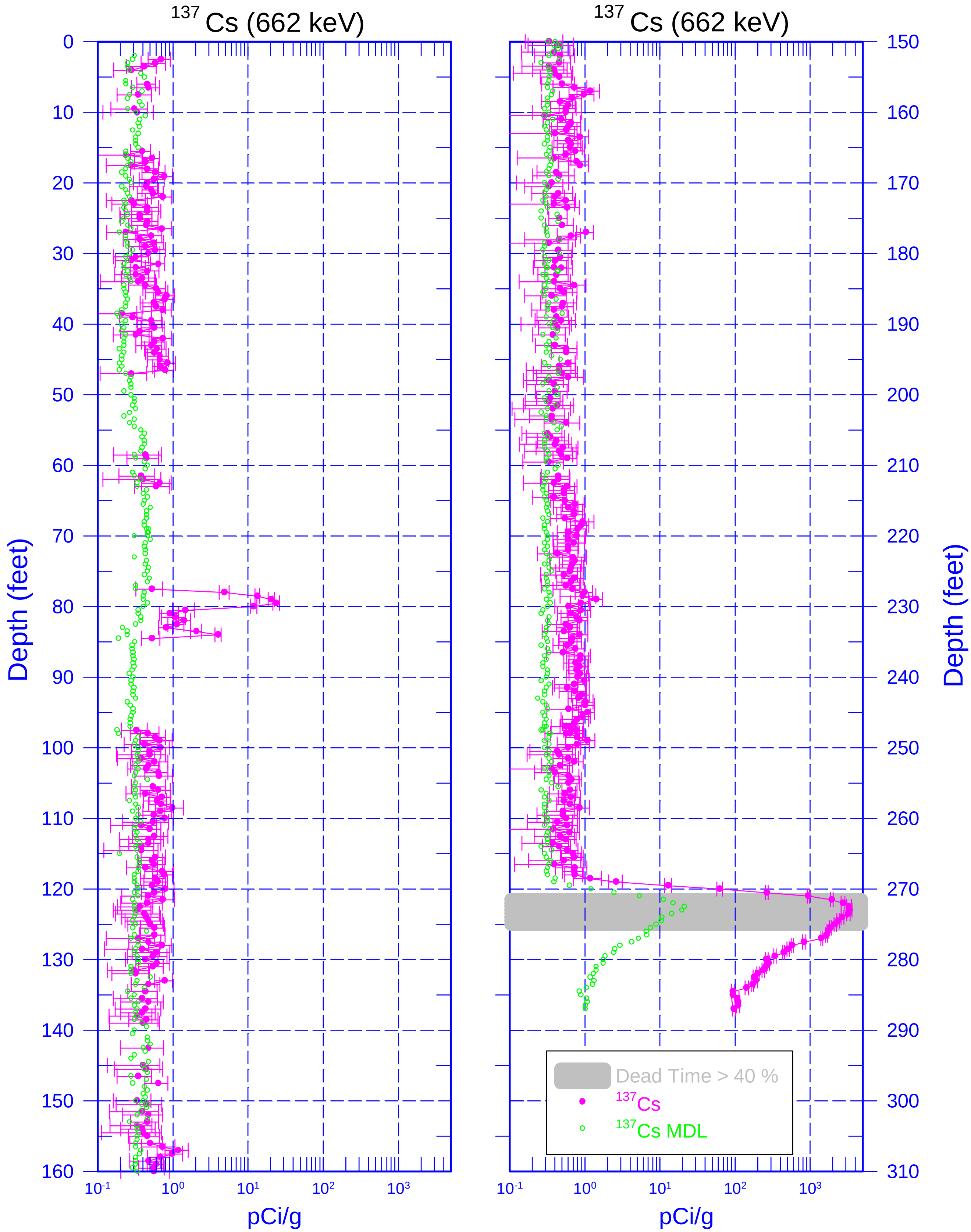
## **References:**

Chamness, M.A., and J.K. Merz, 1993. *Hanford Wells*, PNL-8800, prepared by Pacific Northwest Laboratory for the U.S. Department of Energy.

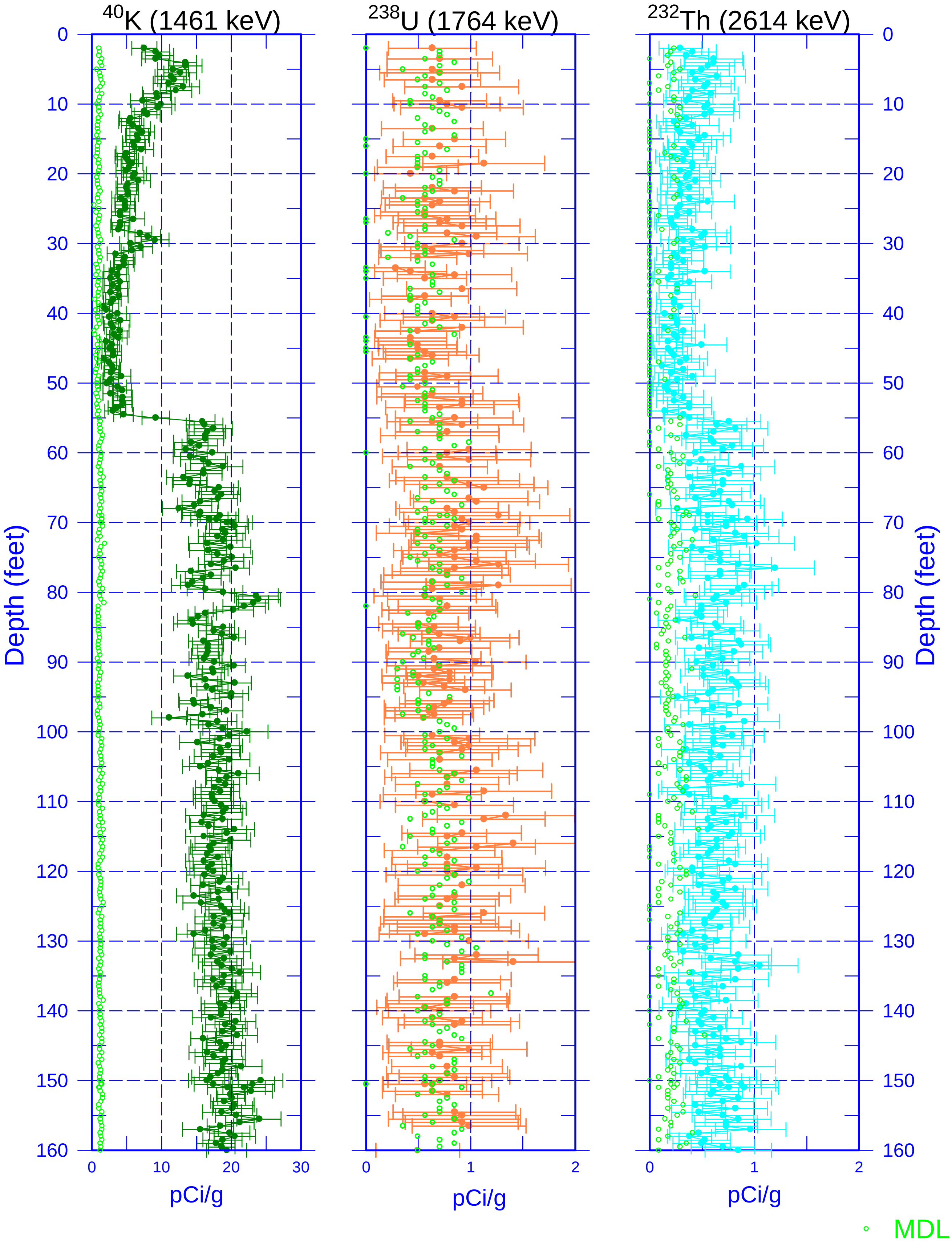
Ledgerwood, R.K., 1992. *Summaries of Well Construction Data and Field Observations for Existing 200-East Aggregate Area Operable Unit Resource Protection Wells*, Draft WHC-SD-ER-T12EAA, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Smith, R.M, 1980. *216-B-5 Reverse Well Characterization Study*, RHO-ST-37, Rockwell Hanford Operations, Richland, Washington.

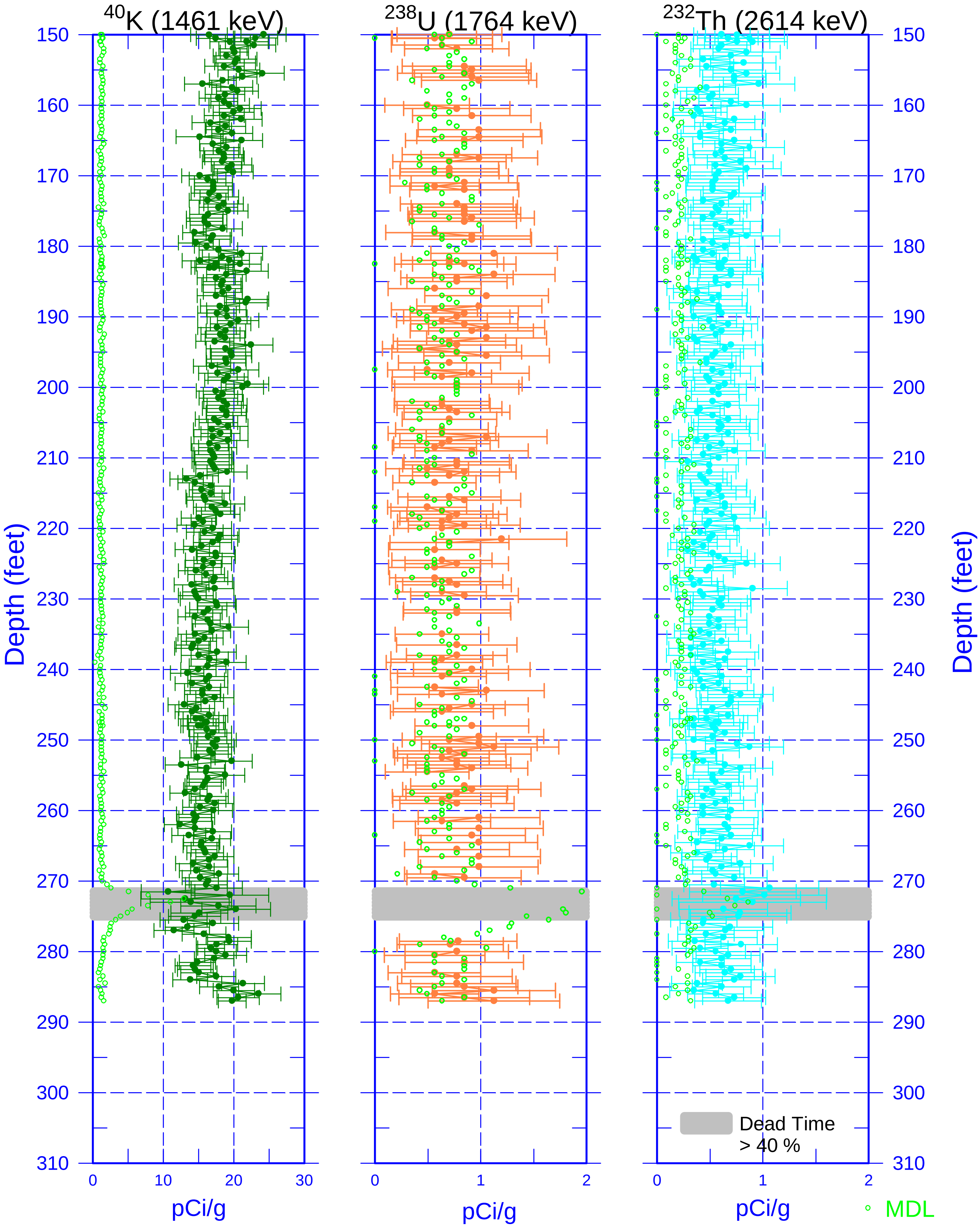
# 299-E28-24 (A6800)
## Man-Made Radionuclide Concentrations



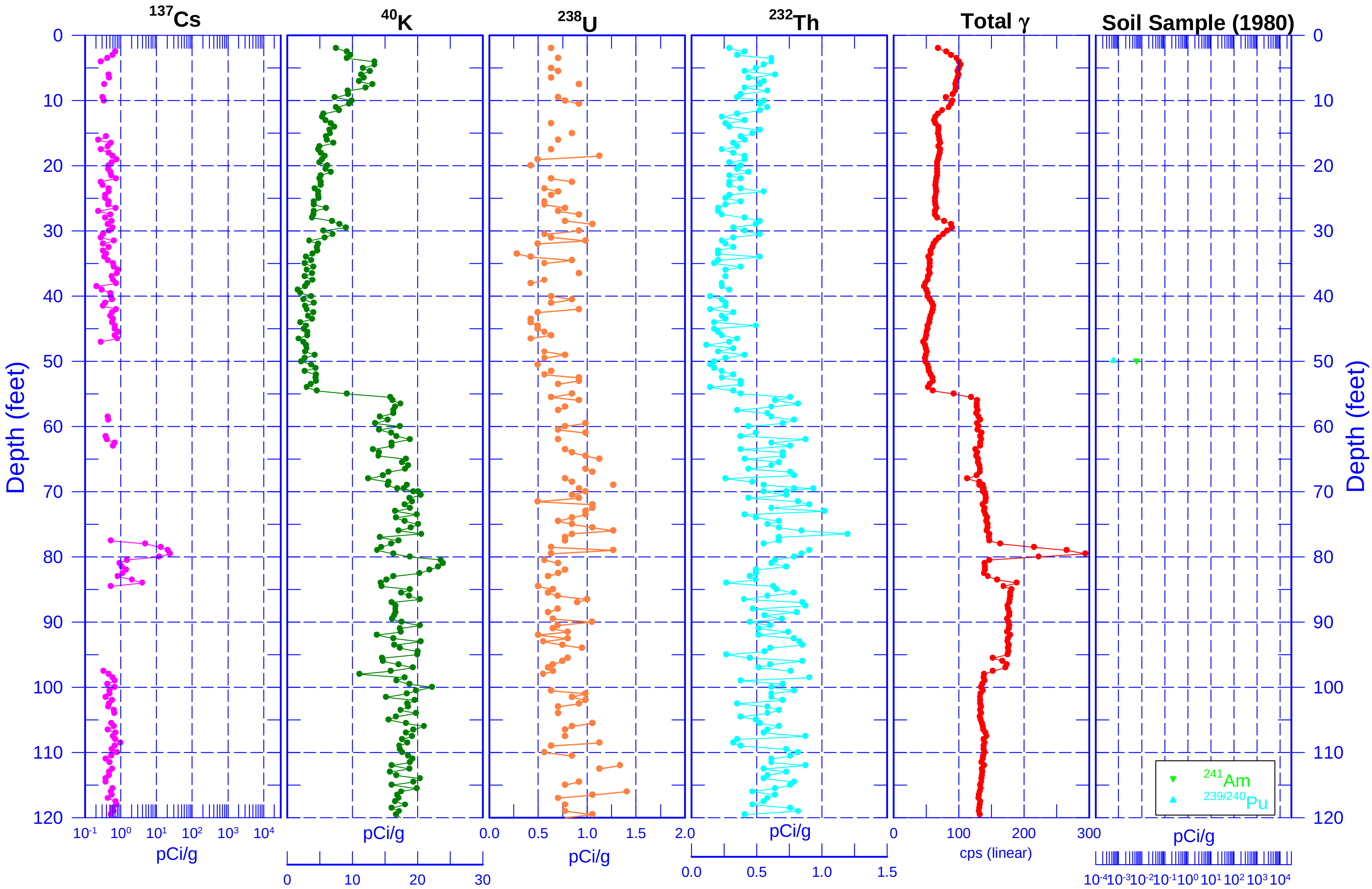
# 299-E28-24 (A6800)
## Natural Gamma Logs



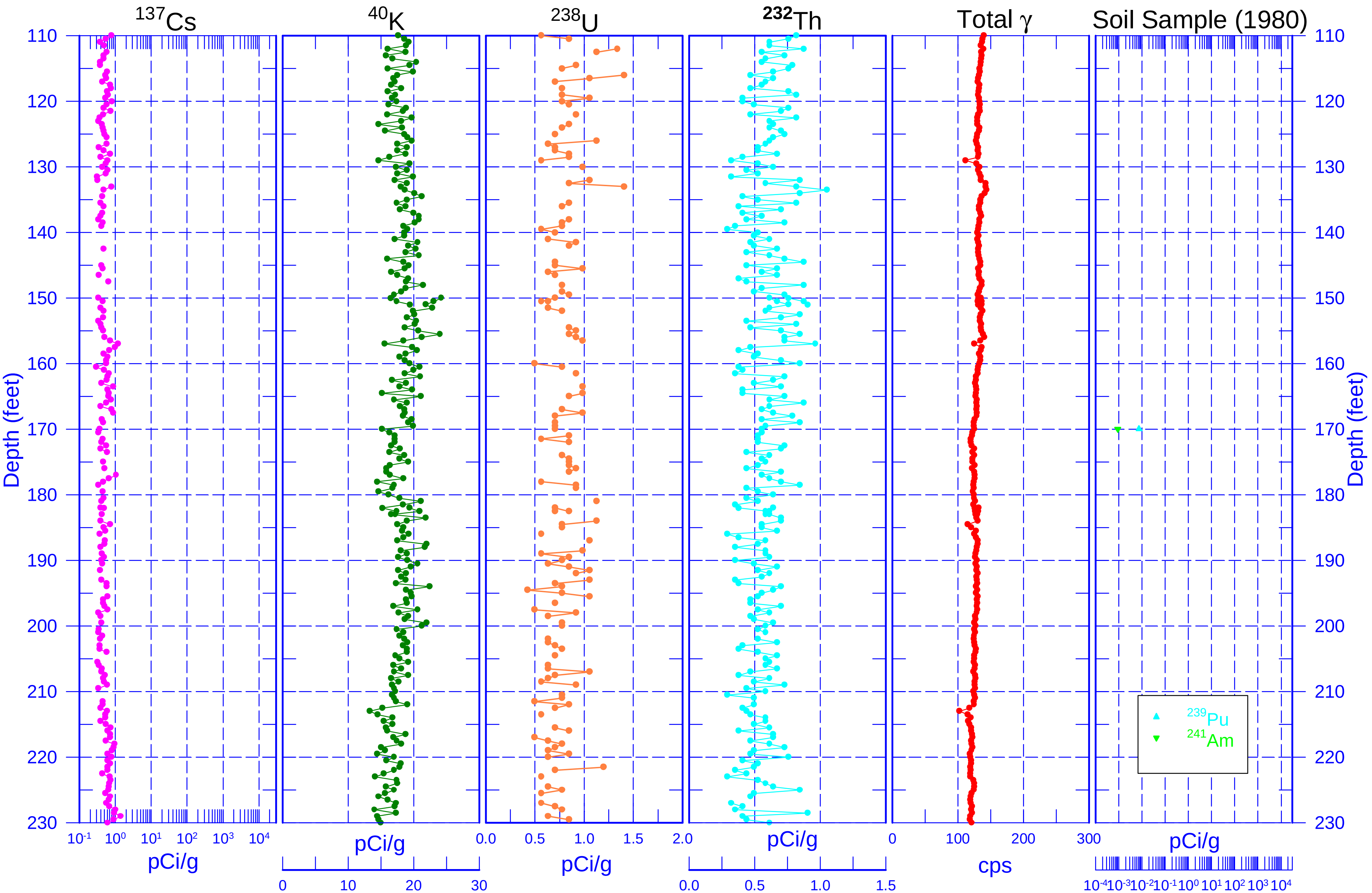
# 299-E28-24 (continued)
## Natural Gamma Logs



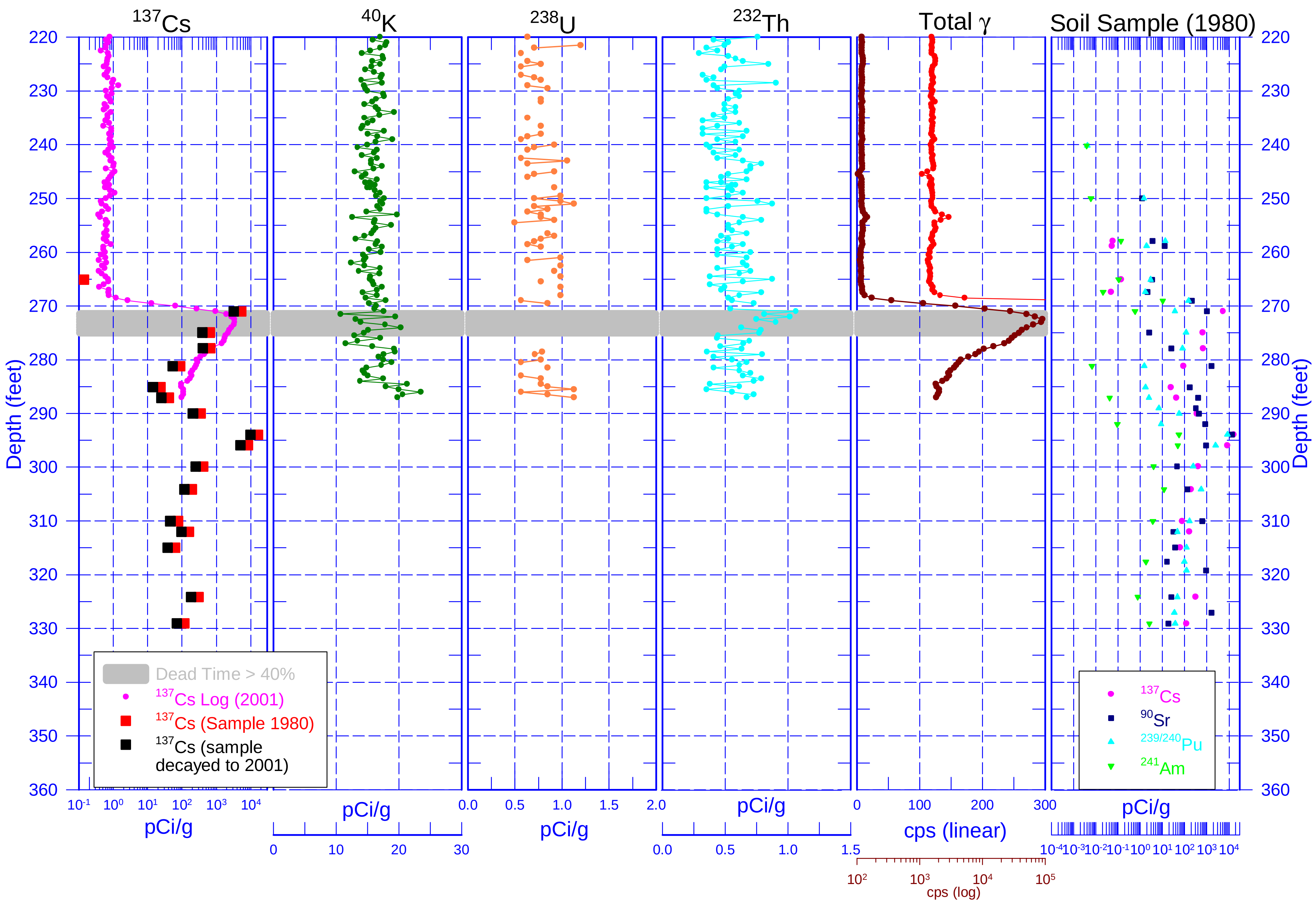
# 299-E28-24 (A6800) Combination Plot



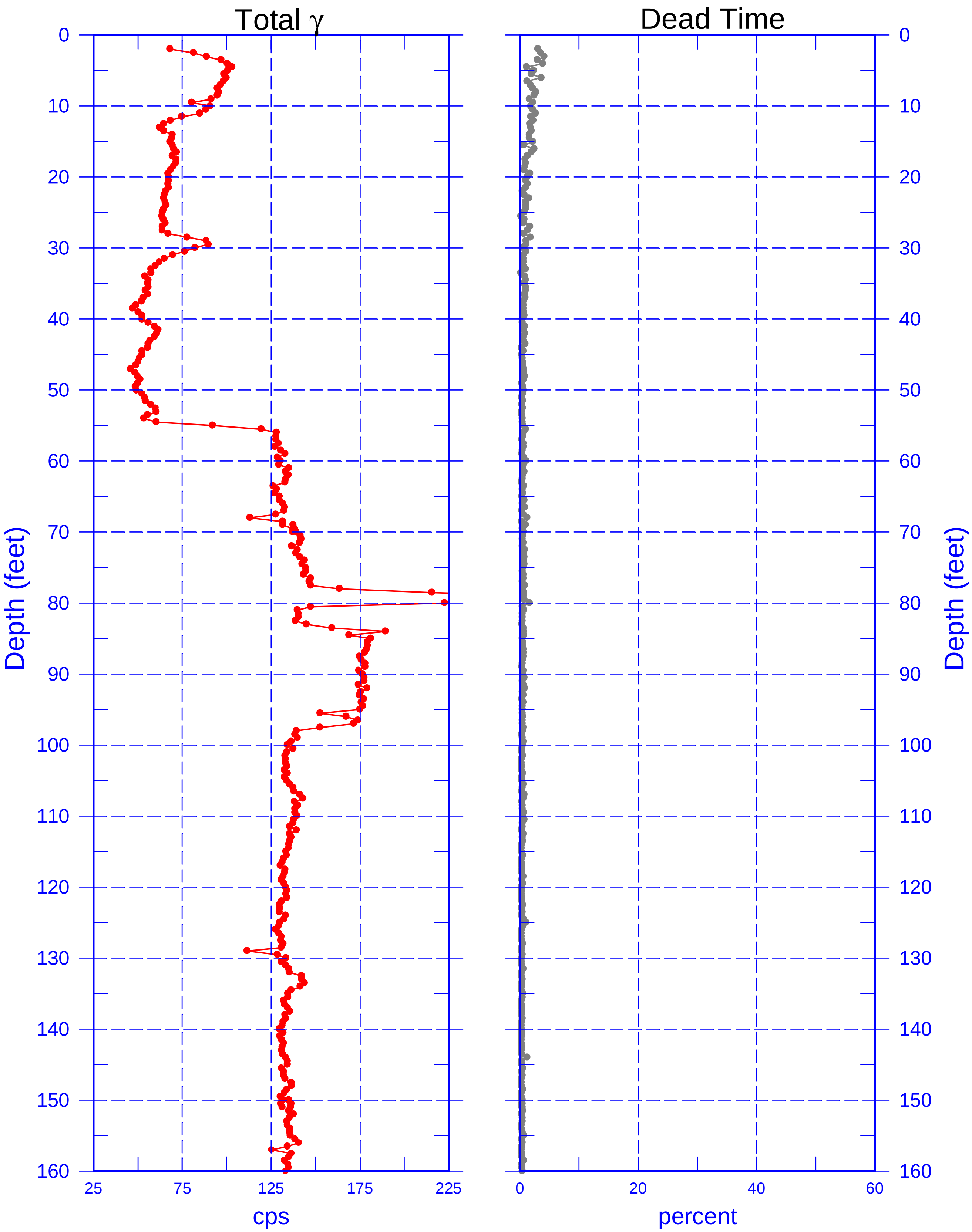
# 299-E28-24 Combination Plot (continued)



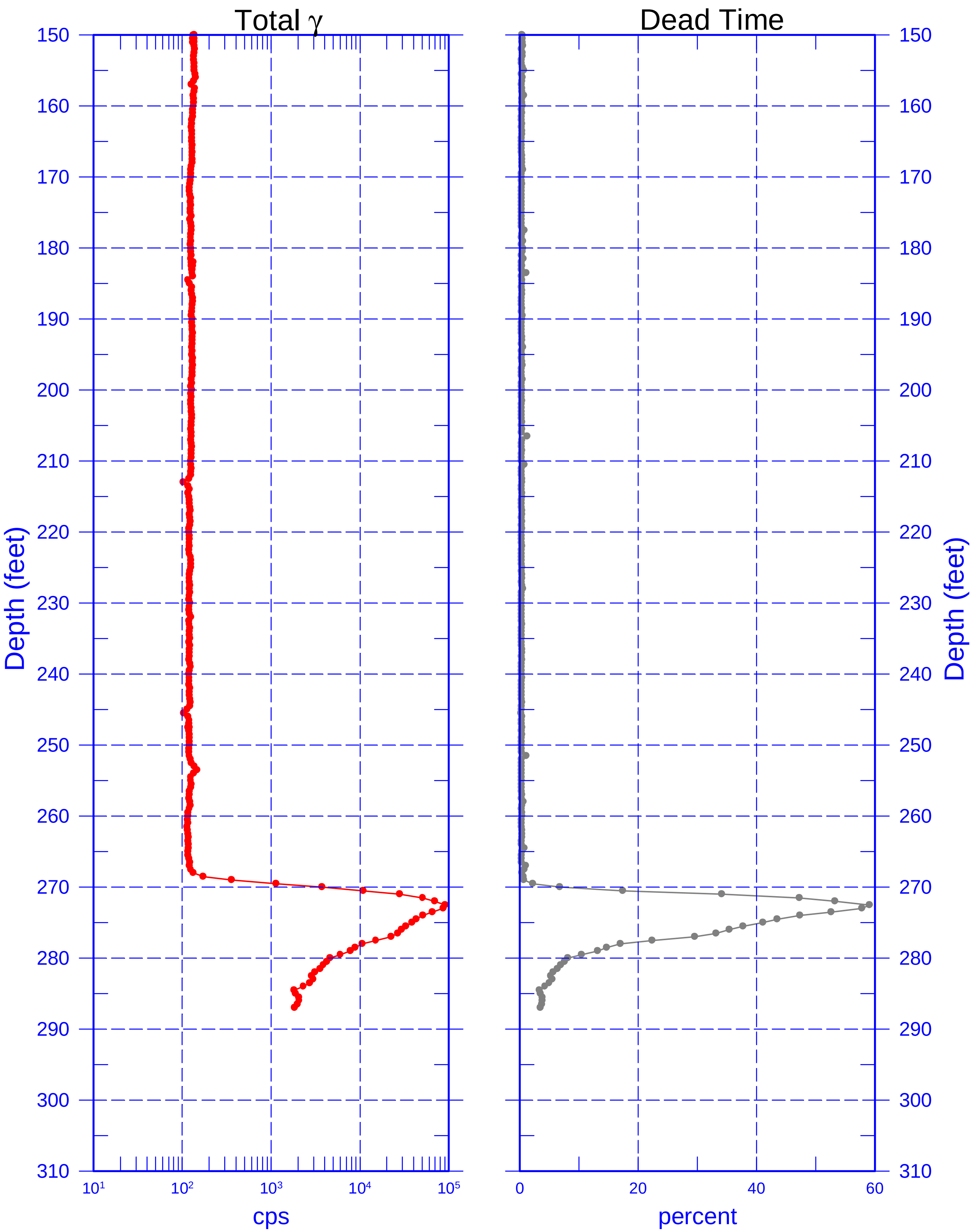
# 299-E28-24 Combination Plot (continued)



# 299-E28-24 (A6800)
# Total Gamma & Dead Time



# 299-E28-24 (continued)
## Total Gamma & Dead Time



# 299-E28-24 (A6800)
## Repeat Logs